UTILITY APPLICATION FOR UNITED STATES PATENT

FOR

FUME HOOD MANAGEMENT SYSTEM

Inventor(s):
Hideya Saito
Yoshihiro Aiiso
Akio Matsumura
Shota Yamada
Nobuhide Honda
Ken Amari

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP
12400 Wilshire Boulevard, Seventh Floor
Los Angeles, California 90025
Telephone: (310) 207-3800

Specification

Title of the Invention

Fume Hood Management System

5   Background of the Invention

The present invention relates to a fume hood which locally exhausts toxic gases generated in an environment such as a research establishment, plant, or hospital, which is hazardous for workers or products

10   and, more particularly, to a fume hood management system which can acquire data related to the safety of workers.

In chemical experiments, gases or dusts that are hazardous for human bodies are often generated in experimental working processes. One of apparatuses that

15   prevent such hazardous substances from diffusing in a room and prevent contamination of human bodies is a fume hood. Generally, a fume hood has an envelope (enclosure) with a sash door that can be opened/closed vertically or horizontally. Workers of a laboratory can

20   access the enclosure through the sash door.

To prevent workers who are working in the fume hood from being exposed to hazardous gases or dusts, the enclosure is connected to an exhaust apparatus for removing the hazardous substances.

25   As an exhaust control method for such an airflow control system having fume hoods and exhaust apparatus, a VAV (Variable Air Volume) method is known,

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which changes the exhaust airflow of the fume hood in accordance with the aperture ratio of the sash. In addition, a UBC (Usage Based Controls (tradename)) method is also known, which detects the presence/absence

5   of workers, increases the exhaust airflow only when workers are present, and decreases the exhaust airflow if no workers are present.

In recent airflow control systems, "diversity" has been introduced as a technique for optimizing the

10 system. The "diversity" is a system design concept based on a statistical value, i.e., a fact that as the simultaneous utilization ratio of fume hoods (the ratio of the number of fume hoods that are being used to the total number of fume hoods) converges to a predetermined

15 value as the number of fume hoods increases.

According to this "diversity" concept, the design maximum exhaust airflow, i.e., the maximum airflow that can be exhausted by the exhaust apparatus can be decreased on the basis of the statistical value.

20 Hence, the energy cost can be effectively reduced while safely operating laboratories.

However, the conventional airflow control systems have no means for measuring the simultaneous utilization ratio during an actual operation. The

25 margin at the time of actual operation with respect to the simultaneous utilization ratio at the design stage cannot be confirmed.

The simultaneous utilization ratio at the time of actual operation changes depending on the facility where the fume hoods are installed. In fact, the simultaneous utilization ratio also changes depending on

5 the scale of the facility and the number of workers. Hence, if the system is designed on the basis of only the statistical simultaneous utilization ratio, it cannot be determined whether the design is appropriate. To ensure sufficient safety, the design margin must be

10 large.

Additionally, the conventional airflow control systems have neither means for measuring the maximum exhaust airflow, i.e., the sum of instantaneous exhaust airflows of the fume hoods nor means for measuring the

15 safety margin, i.e., the difference between the design maximum exhaust airflow and the maximum exhaust airflow. Hence, the degree of safety or the facility allowance cannot be confirmed.

As a consequence, in the conventional airflow

20 control systems, data related to the safety of workers, including the simultaneous utilization ratio at the time of actual operation and the safety margin, cannot be acquired. Hence, it is difficult to evaluate the safety of the system.

25 Summary of the Invention

It is an object of the present invention to provide a fume hood management system which can acquire

data related to the safety of workers.

In order to achieve the above object, according to the present invention, there is provided a fume hood management system comprising collection means
5 for collecting data representing an operation state from a plurality of fume hoods, and a server apparatus which comprises arithmetic means for calculating a simultaneous utilization ratio on the basis of the number of simultaneously used hoods and the total number
10 of fume hoods, the number of simultaneously used hoods being obtained from the data collected by the collection means and representing the number of fume hoods that are being used.

Brief Description of the Drawings

15 Fig. 1 is a block diagram showing the arrangement of a fume hood management system according to an embodiment of the present invention;

Fig. 2A is a block diagram showing the arrangement of a fume hood in the fume hood management
20 system according to the embodiment of the present invention;

Fig. 2B is a block diagram showing the arrangement of a data collection module in the fume hood management system according to the embodiment of the
25 present invention;

Fig. 2C is a block diagram showing the arrangement of a server apparatus in the fume hood

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management system according to the embodiment of the present invention;

Fig. 2D is a block diagram showing the arrangement of a terminal apparatus in the fume hood management system according to the embodiment of the present invention; and

Fig. 3 is a view showing an example of data displayed on the screen of the terminal apparatus shown in Fig. 1.

Description of the Preferred Embodiment

The embodiment of the present invention will be described below in detail with reference to the accompanying drawings.

As shown in Fig. 1, a fume hood management system according to the present invention comprises a plurality of fume hoods 1, a data collection module 2 serving as a collection means for collecting field data representing an operation state from each fume hood 1, and a server apparatus 3 serving as an arithmetic means for calculating the simultaneous utilization ratio or safety margin on the basis of the collected field data.

The fume hood management system according to this embodiment also comprises a plurality of terminal apparatuses 4 which display data transmitted from the server apparatus 3, routers 5 which connect the fume hoods 1 to a network, and a gateway apparatus 6 which connects the network to the data collection module 2.

The fume hood management system according to this embodiment also comprises an intranet 7 connected to the terminal apparatuses 4, and a router 8 which connects the server apparatus 3 to the intranet 7.

As shown in Fig. 2A, each fume hood 1 comprises a transmission/reception section 1a which transmits/receives field data representing an operation state, and a control section 1d which is connected to the transmission/reception section 1a and controls the respective sections.

The fume hood 1 also comprises an aperture ratio sensor section 1b which is connected to the control section 1d and detects and monitors the aperture ratio of the sash door prepared in an enclosure 1c (to be described later). The fume hood 1 also comprises the enclosure 1c which is connected to the aperture ratio sensor section 1b and has an envelope with, e.g., a movable sash door. The fume hood 1 also comprises an operator detection section 1e which is connected to the control section 1d and detects a worker (operator) in front of the fume hood 1. The control section is also connected to an airflow adjusting valve 12.

As the detection section 1e, various means such as an infrared sensor or camera can be used.

To determine whether the sash is open, the method of causing the sash aperture ratio sensor to directly detect the aperture ratio of the sash can be

used. Alternatively, the sash open state may be determined by arithmetically obtaining the aperture ratio of the sash on the basis of a known maximum height of the sash and a sash position detected by a sash

5   position sensor attached to a predetermined position.

It may also be determined that the sash is open when the control signal to the exhaust valve of the fume hood has a value equal to or larger than a predetermined set value (a value at which a

10   predetermined airflow or more should be exhausted) or when the measurement value of an airflow sensor attached to a predetermined position exceeds a predetermined minimum exhaust airflow.

At least one of the aperture ratio sensor

15   section 1b and detection section 1e suffices.

In the present invention, the "safety margin" means the degree of safety for workers and the facility allowance.

As shown in Fig. 2B, the data collection

20   module 2 comprises a transmission/reception section 2a which receives field data representing an operation state, a control section 2b having a collection section 2d which is connected to the transmission/reception section 2a and collects the field data, and a storage

25   section 2c which is connected to the control section 2b and stores the received data.

As shown in Fig. 2C, the server apparatus 3

comprises a transmission/reception section 3a which receives data from the fume hood 1 and data collection module 2, and a control section 3b which is connected to the transmission/reception section 3a and controls the

5   respective sections. The server apparatus 3 also comprises a storage section 3c which is connected to the control section 3b and stores arithmetic results. The server apparatus 3 also comprises an arithmetic section 3d which is connected to the control section 3b and

10   includes a simultaneous utilization ratio calculation section 3e which calculates the simultaneous utilization ratio (to be described later), a maximum exhaust airflow calculation section 3f which calculates the maximum exhaust airflow, and a safety margin calculation section

15   3g which calculates the safety margin.

The terminal apparatus 4 comprises a transmission/reception section 4a which receives data from the server apparatus 3, and a control section 4b which is connected to the transmission/reception section

20   4a and controls the respective sections. The terminal apparatus 4 also comprises a display section 4d which is connected to the control section 4b and displays the received data, and a storage section 4c which stores the received data.

The operation of the fume hood management

25   system will be described below.

When the VAV method is employed as the exhaust

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control method, the control section (control unit) 1d of
each fume hood 1 changes the exhaust airflow by
adjusting the airflow control valve 12 in accordance
with the aperture ratio of a sash 11. For example, when
5   the aperture ratio of the sash 11 is 20% or less, the
control section 1d sets the minimum exhaust airflow.
When the aperture ratio is 50%, the exhaust airflow is
set to 50%. When the aperture ratio is 100%, the
exhaust airflow is set to 100%.

10   When the UBC method is employed as the exhaust
control method, the control section (control unit) 1d of
each fume hood 1 causes the detection section 1e
(detection sensor) installed in the fume hood 1 to
confirm whether a worker (operator) is present in front
15   of the fume hood 1. When a worker (operator) is
present, the exhaust airflow is increased by adjusting
the airflow control valve 12. When no worker is
present, the exhaust airflow is decreased to a safe
standby level.

20   The data collection module 2 periodically
collects field data representing the operation state of
each fume hood 1 from the control unit of the fume hood
1 through the gateway apparatus 6 and router 5.

Field data may contain only instantaneous
25   exhaust airflows, instantaneous exhaust airflows and
sash aperture ratios, or instantaneous exhaust airflows,
sash aperture ratios, and detection results of detection

sensors (the presence/absence of workers). The collectable field data changes depending on the form of the fume hood 1.

The server apparatus 3 stores the field data collected by the data collection module 2 in the internal storage section 3c (storage device). The server apparatus 3 also calculates the number of simultaneously used hoods, the simultaneous utilization ratio, the maximum exhaust airflow, and the safety margin every predetermined time on the basis of the field data.

All the fume hoods 1 shown in Fig. 1 are connected to a single exhaust system 9 so that exhaust is executed. An exhaust fan 10 is attached to the terminal of the exhaust system 9.

The number of simultaneously used hoods is the number of fume hoods 1 that are being used in a total number n (n is a natural number) of fume hoods 1 connected to the exhaust system 9.

The method of determining whether each fume hood 1 is being used changes depending on the type of field data that can be collected from the fume hood 1. The hood 1 whose sash 11 has an aperture ratio equal to or more than a set value may be determined as being used. Alternatively, the hood 1 whose exhaust airflow is equal to or more than a set value may be determined as being used.

The simultaneous utilization ratio is obtained by dividing the number of simultaneously used hoods by the total number n of fume hoods 1.

The maximum exhaust airflow is the sum of instantaneous exhaust airflows of the fume hoods 1 connected to the exhaust system 9. The safety margin is the difference between the maximum exhaust airflow and the design maximum exhaust airflow which is the maximum value of the airflow that can be exahusted by the exhaust system 9.

The design maximum exhaust airflow is a known value, as a matter of course.

The server apparatus 3 stores the calculated number of simultaneously used hoods, simultaneous utilization ratio, maximum exhaust airflow, and safety margin in the internal storage section 3c (storage device) as actual values.

The server apparatus 3 also calculates ideal values together with the actual values and stores the ideal values in the internal storage section 3c (storage device). The ideal values can be obtained when each fume hood 1 has the detection section 1e such as a detection sensor.

The ideal values are obtained by calculating the number of simultaneously used hoods, the simultaneous utilization ratio, the maximum exhaust airflow, and the safety margin while assuming that the

hoods 1 whose sashes 11 are open although the detection
sensors detect no workers are hoods that are not being
used and have the minimum exhaust airflow.

The server apparatus 3 transmits, to the
5 terminal apparatuses 4 through the router 8 and intranet
7, the design maximum exhaust airflow, the actual value
and ideal value of the maximum exhaust airflow, the
actual value and ideal value of the safety margin, the
actual value and ideal value of the number of
10 simultaneously used hoods, and the actual value and
ideal value of the simultaneous utilization ratio.

The server apparatus 3 also transmits, to the
terminal apparatuses 4 through the router 8 and intranet
7, a target exhaust airflow which is set in advance as
15 the target value of reduction of the design maximum
exhaust airflow, the actual value and ideal value of a
target safety margin which is set in advance as the
target value of the safety margin, and the actual value
and ideal value of a target number of simultaneously
20 used hoods, which is set in advance as the target value
of the number of simultaneously used hoods.

The actual value of the target safety margin
(target number of simultaneously used hoods) is obtained
by defining the fume hoods 1 whose sash aperture ratios
25 are equal to or more than a set value or whose exhaust
airflows are equal to or more than a set value as being
used, as described above.

The ideal values are obtained by defining that the hoods 1 whose sashes 11 are open although the detection sensors detect no workers have the minimum exhaust airflow.

5   Each terminal apparatus 4 connected to the intranet 7 is used by a manager who operates the fume hood management system shown in Fig. 1 or a worker who uses the fume hood 1. Each terminal apparatus 4 displays data received from the server apparatus 3 on

10   the display section 4d. Fig. 3 shows an example of data displayed on the screen of the terminal apparatus 4.

In the example shown in Fig. 3, the design maximum exhaust airflow, the actual value and ideal value of the maximum exhaust airflow, the actual value

15   and ideal value of the safety margin, the actual value and ideal value of the number of simultaneously used hoods, the actual value and ideal value of the simultaneous utilization ratio, the target exhaust airflow, the actual value and ideal value of the target

20   safety margin, and the target number of simultaneously used hoods are displayed as numerical values that represent safety indices.

The maximum exhaust airflow, the safety margin, the number of simultaneously used hoods, and the

25   simultaneous utilization ratio are calculated and transmitted by the server apparatus 3 every predetermined time. For this reason, their display

values are updated at all times.

In the example shown in Fig. 3, the actual value and ideal value of the maximum exhaust airflow which changes over time are indicated by graphs. When the actual value of the safety margin exceeds the actual value of the target safety margin, the server apparatus 3 calculates the elapsed time from the start to the end of the excess as the actual value of a target safety margin excess time. When the ideal value of the safety margin exceeds the ideal value of the target safety margin, the server apparatus 3 calculates the elapsed time of the excess as the ideal value of the target safety margin excess time, like the actual value.

When the actual value of the number of simultaneously used hoods exceeds the actual value of the target simultaneous utilization ratio, which is obtained from the actual value of the target number of simultaneously used hoods, the server apparatus 3 calculates the elapsed time from the start to the end of the excess as the actual value of a target simultaneous utilization ratio excess time.

When the ideal value of the number of simultaneously used hoods exceeds the ideal value of the target simultaneous utilization ratio, which is obtained from the ideal value of the target number of simultaneously used hoods, the server apparatus 3 calculates the elapsed time of the excess as the ideal

value of the target simultaneous utilization ratio excess time, like the actual value.

The server apparatus 3 transmits, to the terminal apparatuses 4, the calculated actual value and 5 ideal value of the target safety margin excess time and the actual value and ideal value of the target simultaneous utilization ratio excess time. Each terminal apparatus 4 displays the received data.

In this embodiment, the data collection module 10 2 and server apparatus 3 are separately arranged. However, they may be integrated into one management apparatus. The routers 5, gateway apparatus 6, and router 8 are not always necessary. The arrangement can be appropriately changed in accordance with the network 15 condition of each facility.

As described above, in this embodiment, field data is collected from each fume hood 1, and the simultaneous utilization ratio and safety margin are obtained. Accordingly, quantitative numerical data 20 related to the safety of workers can be acquired, and the safety of the system can be evaluated.

In addition, the margin of the system with respect to the current rating of the exhaust fan 10 can be confirmed on the basis of the data. Hence, how many 25 fume hoods 1 can be added in modifying the facility, or whether the number of exhaust fans 10 must also be increased when the fume hoods needs to be added can be.

appropriately determined.

According to the present invention, data
representing the operation state is collected from each
fume hood 1. The number of simultaneously used hoods,
5   i.e., the number of fume hoods that are being used is
calculated on the basis of the data. When the number of
simultaneously used hoods is divided by the number of
fume hoods, the simultaneous utilization ratio can be
calculated. Data to be used to determine whether the
10   design is appropriate or quantitative numerical data
related to the safety of workers can be acquired. It
can be confirmed on the basis of the numerical data
whether each fume hood is operating safely.

Measures necessary for a safer operation can
15   be quantitatively grasped, and the quantitative
numerical data as the basis of education to the safety
can be presented to workers and the like who use the
fume hoods. In addition, the calculated simultaneous
utilization ratio can be used as basic data in modifying
20   the facility.

The simultaneous utilization ratio is
calculated by defining fume hoods whose detection
sensors detect no workers and whose sashes are open as
fume hoods that are not being used. By using thus
25   calculated simultaneous utilization ratio as an ideal
value, the decrease in simultaneous utilization ratio
when workers close the sashes of the unused fume hoods

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can be confirmed, and the quantitative numerical data as the basis of education to the safety can be presented to workers and the like.

Data representing an operation state is

5   collected from each fume hood 1. The maximum exhaust airflow, i.e., the sum of instantaneous exhaust airflows of the fume hoods is calculated on the basis of the data. Accordingly, the safety margin, i.e., the difference between the design maximum exhaust airflow

10   and the maximum exhaust airflow can be calculated, and quantitative numerical data related to the safety of workers can be acquired. Furthermore, whether each fume hood is operating safely can be confirmed from the numerical data.

15   Moreover, measures necessary for a safer operation can be quantitatively grasped, and the quantitative numerical data as the basis of education to the safety can be presented to workers and the like who use the fume hoods. In addition, the calculated safety

20   margin can be used as basic data in modifying the facility.

The safety margin is calculated by assuming that the exhaust airflows of fume hoods whose detection sensors detect no workers and whose sashes are open

25   equal a predetermined minimum exhaust airflow. By using thus calculated safety margin as an ideal value, the increase in safety margin when workers close the sashes

of the unused fume hoods can be confirmed, and the

quantitative numerical data as the basis of education to

the safety can be presented to workers and the like.